

University of Wollongong - Research Online

Thesis Collection

Title: Pollination ecology and molecular systematics of *Diuris* (Orchidaceae)

Author: James Otto Indsto

Year: 2009

Repository DOI:

Copyright Warning

You may print or download ONE copy of this document for the purpose of your own research or study. The University does not authorise you to copy, communicate or otherwise make available electronically to any other person any copyright material contained on this site.

You are reminded of the following: This work is copyright. Apart from any use permitted under the Copyright Act 1968, no part of this work may be reproduced by any process, nor may any other exclusive right be exercised, without the permission of the author. Copyright owners are entitled to take legal action against persons who infringe their copyright. A reproduction of material that is protected by copyright may be a copyright infringement. A court may impose penalties and award damages in relation to offences and infringements relating to copyright material.

Higher penalties may apply, and higher damages may be awarded, for offences and infringements involving the conversion of material into digital or electronic form.

Unless otherwise indicated, the views expressed in this thesis are those of the author and do not necessarily represent the views of the University of Wollongong.

Research Online is the open access repository for the University of Wollongong. For further information contact the UOW Library: research-pubs@uow.edu.au

2009

Pollination ecology and molecular systematics of *Diuris* (Orchidaceae)

James Otto Indsto
University of Wollongong

Follow this and additional works at: <https://ro.uow.edu.au/theses>

University of Wollongong

Copyright Warning

You may print or download ONE copy of this document for the purpose of your own research or study. The University does not authorise you to copy, communicate or otherwise make available electronically to any other person any copyright material contained on this site.

You are reminded of the following: This work is copyright. Apart from any use permitted under the Copyright Act 1968, no part of this work may be reproduced by any process, nor may any other exclusive right be exercised, without the permission of the author. Copyright owners are entitled to take legal action against persons who infringe their copyright. A reproduction of material that is protected by copyright may be a copyright infringement. A court may impose penalties and award damages in relation to offences and infringements relating to copyright material.

Higher penalties may apply, and higher damages may be awarded, for offences and infringements involving the conversion of material into digital or electronic form.

Unless otherwise indicated, the views expressed in this thesis are those of the author and do not necessarily represent the views of the University of Wollongong.

Recommended Citation

Indsto, James Otto, Pollination ecology and molecular systematics of *Diuris* (Orchidaceae), Master of Science - Research thesis, Institute for Conservation Biology and Law, Biological Sciences, University of Wollongong, 2009. <https://ro.uow.edu.au/theses/3107>

NOTE

This online version of the thesis may have different page formatting and pagination from the paper copy held in the University of Wollongong Library.

UNIVERSITY OF WOLLONGONG

COPYRIGHT WARNING

You may print or download ONE copy of this document for the purpose of your own research or study. The University does not authorise you to copy, communicate or otherwise make available electronically to any other person any copyright material contained on this site. You are reminded of the following:

Copyright owners are entitled to take legal action against persons who infringe their copyright. A reproduction of material that is protected by copyright may be a copyright infringement. A court may impose penalties and award damages in relation to offences and infringements relating to copyright material. Higher penalties may apply, and higher damages may be awarded, for offences and infringements involving the conversion of material into digital or electronic form.

Pollination Ecology and Molecular Systematics of *Diuris*
(Orchidaceae)

James Otto Indsto, BSc. (Macquarie University)

Institute for Conservation Biology and Law,
Biological Sciences,
Faculty of Science,
University of Wollongong

A thesis submitted in fulfilment of the requirements of the degree of
Master of Science – Research
University of Wollongong

August 2009

Declaration

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution. To the best of my knowledge and belief, this thesis contains no material previously published or written by another person, except where due reference has been made in the text.

I give consent to this copy of my thesis, when deposited in the University Library, being available for loan and photocopying.

A handwritten signature in black ink, appearing to read 'James Indsto', with a stylized flourish at the end.

21st April, 2010

James Otto Indsto, BSc. (Macquarie University)

Institute for Conservation Biology and Law,

Biological Sciences,

Faculty of Science,

University of Wollongong

Abstract

The Australian terrestrial orchid genus *Diuris* is currently recognised to contain at least 61 species, with numerous new taxa expected to be recognised in the near future. Species are restricted to Australia, with the exception of *Diuris fryana*, which is endemic to Timor. Species of *Diuris* are well represented in the southern parts of western and eastern Australia, separated by the Nullarbor Plain, with a few species found in tropical Queensland. The eastern and western species mostly fall into morphologically distinct groups suggestive of distinct phylogenetic lineages.

Despite considerable variation between and even within species, *Diuris* species share certain important features. Most species occur in open forest and woodland and have flowers that bear a resemblance to Australian native ‘egg and bacon’ pea flowers of the tribes Bossiaceae and Mirbeliae, with which they are frequently sympatric. In some species, the resemblance is very close, in others it is more general. Most existing work on pollination in this taxon is of an anecdotal nature, with only one formal study prior to this project, of one species (*Diuris maculata* at Fern Tree Gully, near Melbourne, Victoria in 1986). The Beardsell *et al.* (1986) study proposed that this orchid was a non-rewarding floral mimic of pea flowers of the genera *Daviesia*, *Pultenaea* and *Dillwynia*. It was sympatric with the peas, with which it bore a visual resemblance, flowered at the same time and was visited by native bees, plus a wasp species that pollinated the pea flowers.

The overall purpose of my project was to advance knowledge of the pollination biology of *Diuris*. In particular, I planned to (i) test the effectiveness of AFLP markers for identifying the source of pollinium remnants collected from the bodies of putative

pollinators, (ii) conduct detailed pollination studies on two species in the Sydney region (*D. maculata* and *D. alba*) to test the generality of the conclusion of floral mimicry in *Diuris*, drawn from the 1986 study in Melbourne; (iii) survey pollinator interactions in a range of taxa (*D. aurea*, *D. punctata* and *D. sp. aff. punctata* (Mellong Swamp)), using pollination observations, imaging of ultraviolet visual cues, colorimetric analysis of putative model and mimic flowers, testing for nectar production and DNA-based identification of pollinaria removed from captured insects, to test for patterns in pollinator-plant associations, and (iv) place these observations in the context of a complete a phylogenetic analysis of the genus *Diuris*.

These main experimental findings are summarised as follows:

1. Amplified Fragment Length Polymorphism (AFLP) was shown not only to be capable of distinguishing many species, but also to possess high sensitivity. This latter feature had not been exploited previously. (See Chapter 2)
2. The pollination mechanism of *Diuris maculata* in this population was shown to be similar to the original Beardsell *et al.* (1986) study, but there were some significant differences – the timing of orchid flowering early in the flowering season of putative model pea species (cf. synchronised flowering in the Victorian population) and the role of male bees (cf. various male and female bees) in pollination, which may be quite common in *Diuris*. (See Chapter 3)
3. *Diuris alba* has flowers that are similar in form, but not colour, to other, putative pea-mimicking *Diuris* species. *Diuris alba* at Munmorah, New South Wales, was found to occur in a variety of

habitats including sites where pea flowers are absent or rare and the pollination success was found to be not dependent on pea flowers. This species was also found to produce a meagre nectar reward. (See Chapter 4)

4. Unpublished pollination data were obtained for a number of *Diuris* taxa (*Diuris aurea* (Castlereagh Nature Reserve), *D. punctata* (Castlereagh Nature Reserve), *D. sp. aff. punctata* (Mellong Swamp), *D. arenaria* (Tomaree National Park) and *Diuris sulphurea* form Stringy Bark Ridge, Pennant Hills. It was found that *D. aurea*, *D. punctata* and *D. sp. aff. punctata* showed pollination features consistent with Batesian-type floral mimicry of yellow ‘egg and bacon’ pea flowers, despite the latter two taxa having a white floral anthoxanthin base colour (with pink/purple suffusions). Additionally, preliminary data was obtained for *D. aurea* and *D. sp. aff. punctata* that showed higher pollination success for plants clustered some distance from yellow pea flowers than was obtained for plants scattered among yellow pea flowers. The taxon *D. arenaria* was shown to have higher reproductive success, when scattered amongst yellow ‘egg and bacon’ pea flowers than would be expected for a Batesian-type mimic, a result suggestive of a more generalised pollination strategy. Meagre nectar was found in one plant of *Diuris sulphurea* tested for nectar production, an interesting result that requires confirmation with further testing.
5. The molecular phylogenetic analysis of *Diuris* (Orchidaceae) based on AFLP and ITS (Internal Transcribed Spacers of Ribosomal DNA)

revealed three major clades and a basal species. *Diuris sulphurea* (subg. *Paradiuris*) is shown to a monotypic sister group to the rest of *Diuris*. (See Chapter 5)

The conclusions of the study can be summarised as follows:

1. Some species show close visual mimicry of specific model species (strict Batesian mimicry) e.g. *Diuris aequalis* is proposed to mimic *Gompholobium* spp.
2. Many species show a more generalised mimicry of peas (loose Batesian-type mimicry) e.g. *Diuris maculata* shows general similarity to ‘egg and bacon’ peas. Over its wide distribution (southern Victoria to north of Sydney, New South Wales) this orchid occurs at many sites and its pollination is likely to involve dozens of species of both peas and pollinators.
3. Some species show apparent dependence on mimicry while showing only aspects of similarity, with other different, perhaps flamboyant features suggestive of non-model mimicry e.g *Diuris* sp. aff. *punctata* (Mellong Swamp). This species shows pollination outcomes in the presence of the yellow pea *Dillwynia glaberrima* as expected for a yellow-flowered pea mimic. Its flowers show general pea-like form. However, the pink/purple floral colouration is quite different to the sympatric yellow peas. It is also noticeably fragrant. It is suggested that the flowers of this species are ‘exciting’ to a bee foraging on pea flowers because its flowers possess strong floral cues, which could be considered to transcend strict mimicry.

4. Generalised pollination e.g. *Diuris alba* from Munmorah, New South Wales. In this case flowers were shown to have pea-like floral form, but with different colour (white cf. yellow), fragrance and nectar. Plants were shown to have high pollination success both in the presence and absence of pea flowers. The pollination system was analysed using colorimetric analysis with a model of predicted colour-based foraging errors. This pollination system was proposed to have evolved from pea mimicry and not entirely disconnected from it. Aspects of Batesian-type mimicry, non-model mimicry, the ‘magnet effect’ and the presence of a meagre nectar reward may all contribute to high pollination success in varied environments.
5. *Diuris sulphurea* is the most widespread of all *Diuris* species in eastern Australia, forms a basal clade to the rest of the genus and may show ancestral pollination features. Such a widespread species is unlikely to mimic a single pea species and must show fairly generic pea mimicry. It has a colony-forming growth habit, produces nectar and has high reproductive success. An understanding of its pollination mechanism is likely to lead to insights of pollination evolution within the genus.

The phylogenetic data allow the following interpretations of current patterns of *Diuris* pollination:

1. The finding that *D. sulphurea* forms basal clade to all other *Diuris* suggests that this species may possess ancestral features, including pollination mechanism, which on the basis on preliminary evidence

would appear to be fairly generalised (guild) pea mimicry combined with nectar reward. Its pollination mechanism, combined with a colony-forming habit might be expected to promote significant self-pollination.

2. Knowledge of species groupings (clades) will aid in focusing pollination studies since clades can be expected to contain species sharing morphological and pollination features.
3. Yellow base colour can be inferred to be ancestral in *Diuris*, with pink/purple colouration being a synapomorphy in *Diuris* subg. *Diuris* sect. *Purpureo-albae* (plus some species within *Diuris* subg. *Xanthodiuris*, sect. *Pedunculatae*, e.g. *D. venosa*). Preliminary data suggest that despite the floral colour difference, species closely related to *D. punctata* appear to mimic yellow pea flowers and have a similar pollination mechanism, while another closely related species, *D. alba* has been shown to have generalised pollination. Therefore, a detailed understanding of pollination of the species *D. aurea*, *D. punctata*, and *D. alba* can be expected to provide considerable information about pollination within this large species group and also to provide important insights into the evolution of Batesian-type mimicry in this orchid group.

I propose the following hypothesis about the role of Batesian-type mimicry (which includes strict Batesian mimicry as commonly understood and looser forms, such as mimicry of a guild of Mullerian mimics) in the pollination systems of

Australian east coast *Diuris* species. Strict Batesian mimicry is highly specialised and inevitably leads to rarity, and there are consequently few examples. However, the looser type of Batesian mimicry (sometimes termed ‘guild mimicry’) exemplified by *Diuris maculata* permits the exploitation of many ecologically similar environments, in which basically similar, but distinct pea flower species may all serve as models for this orchid. Within *Diuris*, subg. *Diuris*, sect. *Purpureo-albae* there are numerous species with pink/purple, or white base colour. Many of these, paradoxically, appear to depend on association with yellow ‘egg and bacon’ peas for pollination. Phylogenetic evidence suggests that these species have undergone recent and rapid evolutionary radiation. This could be viewed as a shift toward even looser Batesian-type mimicry and could account for their evolutionary success. *Diuris alba* represents a group of species which have developed a sufficiently generalised pollination system to be independent of pea flowers, although high reproductive success in the presence of pea flowers would suggest that the link to pea mimicry is not completely broken. It thus may be reasonably termed a ‘non-model’ mimic and it likely benefits from the ‘magnet effect’ of being in the proximity of abundant rewarding species (which often happen to be pea flowers). As resemblance of this species to pea flowers is somewhat unclear, it may not be meaningful to view pea flowers as ‘model’ flowers, or indeed this orchid as a pea ‘mimic’.

Acknowledgements

I acknowledge the financial support of the Hermon Slade Orchid Trust, the Australian Orchid Foundation and the Joyce Vickery Scientific Research Fund and to thank my project supervisors for their contributions to my research and for assistance in the preparation of publications: Professor Rob Whelan (now President, Dubai Campus, University of Wollongong), Dr Peter Weston (Senior Principal Research Scientist, Royal Botanic Gardens and Domain Trust, Sydney), Dr Mark Clements (Senior Research Scientist, Centre for Plant Biodiversity Research, CSIRO, ACT) and Dr Adrian Dyer (Brain and Behaviour Research Centre, Department of Physiology, Monash University). In particular, Dr Peter Weston and Prof. Rob Whelan have provided considerable assistance in the editing of manuscripts and the thesis.

I also acknowledge the direct contribution to research outcomes made by my research supervisors in their capacity as research colleagues who have contributed to published studies. The specific contributions of these scientists are detailed in a prologue to each of the published research chapters (Chapters 2, 3, 4 and 5). Finally, I wish to thank the thesis examiners for their enthusiastic support of this work and their many helpful comments to clarify the expression of ideas, in correcting numerous grammatical errors and factual details, and, most importantly in duly acknowledging scientific priority of many ideas which appear in numerous scientific papers, which in some cases require some detective work to find a first mention in the scientific literature.

Acknowledgements relating to each of the published research chapters can be found at the end of each of these chapters as they appeared in the published articles.

Table of Contents

Declaration.....	2
Abstract.....	3
Acknowledgements.....	10
Table of Contents.....	11
List of Figures.....	17
List of Tables.....	19
CHAPTER 1: General Introduction.....	21
1. A Brief History of Ideas in Pollination Biology.....	21
2. Flower Visits by Hymenopteran Insects.....	25
3. The Antiquity of the Association of Bees and Flowers – Linked in Evolutionary Stasis.....	33
4. Specialised Features of Bee-pollinated Flowers.....	35
5. Special Features of Orchid Flowers.....	37
6. Deceptive Pollination is Common in the Orchid Family.....	38
7. Batesian and Batesian-type Mimicry in Plants, Especially Orchids.....	38
8. Advances Beyond Descriptive Studies.....	44
9. Phylogenetic Analysis and Pollination Ecology.....	46
10. Pollination in <i>Diuris</i>	49
11. Summary of Main Aims / Hypotheses Tested in this Project.....	55
CHAPTER 2: Highly Sensitive DNA Fingerprinting of Orchid Pollinaria Remnants Using AFLP.....	56
Title Page.....	56

Prologue.....	56
Abstract.....	57
Introduction.....	57
Materials and Methods.....	61
<i>AFLP Simulation Experiment Using Varying Template</i>	
<i>Concentrations.....</i>	62
<i>DNA Extraction and AFLP of Orchid Pollinaria and Pollinaria</i>	
<i>Remnants.....</i>	64
Results and Discussion.....	66
<i>AFLP Simulation Experiment Using Varying DNA Template</i>	
<i>Amounts.....</i>	66
<i>AFLP from Orchid Pollinaria and Pollinaria Remnants.....</i>	66
Acknowledgements.....	74

CHAPTER 3: Pollination of *Diuris maculata* by male *Trichocolletes venustus*

bees.....	75
Title Page.....	75
Prologue.....	76
Abstract.....	76
Introduction.....	77
Materials and Methods.....	80
<i>Pollination Statistics.....</i>	84
<i>Pollinator Sampling.....</i>	84
<i>Pollen Analysis.....</i>	85
<i>DNA Analysis of Pollinaria and Remnants Using AFLP.....</i>	85

<i>Testing of Visual Cues using Ultraviolet Reflectance Photography</i>	
<i>And Colorimetric Analysis</i>	85
<i>Nectar Sampling</i>	88
Results.....	88
<i>Putative Pollinators</i>	88
<i>Bee Sampling</i>	89
<i>Flowering Phenology and Pollination Statistics</i>	91
<i>Ultraviolet Imaging</i>	94
<i>Colorimetric Analysis</i>	96
<i>Pollen Analysis</i>	98
<i>Nectar Sampling</i>	98
Discussion.....	98
Acknowledgements.....	110
 CHAPTER 4: Generalised Pollination of <i>Diuris alba</i> by Small Bees and Wasps..	111
Title Page.....	111
Prologue.....	111
Abstract.....	112
Introduction.....	113
Materials and Methods.....	116
<i>Observation of Putative Pollinators, Pollen Analysis and Pollination</i>	
<i>Statistics</i>	118
<i>Nectar Sampling</i>	118
<i>DNA analysis of Pollinaria and Remnants Using AFLP</i>	119
<i>UV-reflectance Photography</i>	120

<i>Colorimetric Analysis</i>	120
Results.....	121
<i>Observations of Putative Pollinators</i>	121
<i>AFLP Analysis of Orchid Pollinaria</i>	127
<i>UV-Reflectance Photography</i>	127
<i>Colorimetric Analysis</i>	129
<i>Nectar Sampling</i>	130
<i>Pollination Statistics</i>	131
<i>Some Floral Observations</i>	132
Discussion.....	134
Acknowledgements.....	138
 CHAPTER 5: A Molecular Phylogenetic Analysis of <i>Diuris</i> (Orchidaceae) Based on AFLP and ITS Reveals Three Major Clades and a Basal Species	139
Title Page.....	139
Prologue.....	139
Abstract.....	140
Introduction.....	141
Materials and Methods.....	145

<i>Plant Samples</i>	145
<i>Morphological Analysis</i>	149
<i>AFLP Analysis</i>	152
<i>Combined ITS1-5.8S-ITS2 rDNA (ITS) plus Indels Analysis</i>	155
<i>Total evidence analysis</i>	157
Results.....	158
Discussion.....	163
Acknowledgements.....	173
 CHAPTER 6: Preliminary Pollination Data and Other Observations for <i>Diuris</i> in 2003	174
1. <i>Diuris punctata</i> at Castlereagh Nature Reserve.....	174
2. <i>Diuris aurea</i> at Castlereagh Nature Reserve.....	176
3. <i>Diuris</i> sp. aff. <i>punctata</i> at Mellong Swamp, New South Wales.....	178
4. <i>Diuris arenaria</i> at Tomaree National Park (Anna Bay), New South Wales.....	181
5. <i>Diuris sulphurea</i> at Stringy Bark Ridge, Pennant Hills, New South Wales.....	182
6. Concluding Remarks.....	182
 CHAPTER 7: General Conclusions	185
1. Introduction.....	185
2. General Pea Mimicry Appears Common in East Coast Species.....	185

3. Strict Batesian Mimicry (close resemblance to a specific model) Appears Rare.....	187
4. Some <i>Diuris</i> Push the Boundaries of Mimicry – and Yet May Still Depend on Mimicry for Pollination.....	187
5. Generalised Pollination in <i>Diuris</i> – Pollination Success Independent of Peas.....	189
6. The Basal Species <i>Diuris sulphurea</i>	191
7. Hypotheses of Evolutionary Drivers in <i>Diuris</i> Pollination and Ecological Niches.....	193
8. A Consideration of Experimental Methods.....	196
9. DNA-based Identification of Orchid Pollinaria.....	197
10. Mapping of Pollination Systems on to Phylogenetic Trees.....	198
References.....	200
Appendices.....	215
Appendix 1.....	215
Tables of details for captured insects for 2001, 2002 and 2003.	
Appendix 2.....	240
<i>Diuris</i> species and natural hybrids recognized as at June, 2008.	

List of Figures

Chapter 2: Highly Sensitive DNA Fingerprinting of Orchid Pollinaria Remnants Using AFLP

Figure 2.1. Illustrations of sources of orchid pollinaria used in this study.....	63
Figure 2.2. Agarose gel showing genomic DNA and pre-selective PCR products.	69
Figure 2.3. AFLP simulation experiment results	70
Figure 2.4. AFLP results with the selective primer combination	71

Chapter 3: Pollination of *Diuris maculata* R. Br. (Orchidaceae) by Male *Trichocolletes venustus* Bees

Figure 3.1. <i>Diuris maculata</i> flowering plant.....	80
Figure 3.2. Illustration of bee foraging behaviour and pollen types encountered.....	88
Figure 3.3. Comparative black and white photographs in the human visible range (HVS) compared with corresponding near-UV images.....	93
Figure 3.4. Flower colours for <i>Hardenbergia violacea</i> (A), <i>Diuris maculata</i> (B) and <i>Daviesia ulicifolia</i> ssp. <i>ulicifolia</i> (C) plotted in a colour hexagon.....	95
Figure 3.5. Comparative human visible range (HVR) and UV images of orchid and sympatric legume flowers.....	105
Figure 3.6. Comparative human visible range (HVR) and UV images of orchid and sympatric legume flowers.	106

Chapter 4: Generalised Pollination of *Diuris alba* (Orchidaceae) by Small Bees and Wasps

Figure 4.1. <i>Diuris alba</i> from Lake Munmorah, New South Wales.....	112
Figure 4.2. Images of bees showing foraging behaviour and collected pollinaria.....	120
Figure 4.3. Comparative colour and black and white photographic images of <i>Diuris aurea</i> (top left), <i>D. alba</i> (top right), <i>Dillwynia retorta</i> (bottom left) and <i>Pimelea linifolia</i> ssp. <i>linifolia</i> (bottom right).....	125
Figure 4.4. Representative species from Site A plotted in a colour hexagon for the bee visual system. (A) <i>Diuris aurea</i> , (B) <i>Diuris alba</i> , (C) <i>Dillwynia retorta</i> , (D) <i>Mirbelia rubiifolia</i>	127
Figure 4.5. Observations of <i>Diuris alba</i> flowers.....	130
 Chapter 5: A Molecular Phylogenetic Analysis of <i>Diuris</i> (Orchidaceae) Based on AFLP and ITS Reveals Three Major Clades and a Basal Species	
Figure 5.1. The one tree of length 39 steps produced by parsimony analysis of AFLP data, showing branch lengths estimated under the ACCTRAN algorithm.....	158
Figure 5.2. One of >1.9 million trees of length 376 steps produced by the analysis of ITS nucleotide sites plus coded indels, showing branch lengths estimated under the ACCTRAN algorithm.....	161
Figure 5.3. Bootstrap 50% majority rule consensus tree for a total of 50 terminals, including 48 ingroup terminals, produced by analysis of ITS nucleotide sites plus coded indels.....	162
Figure 5.4. Bootstrap 50% consensus tree for a total of 59 terminals, including 57 ingroup terminals, produced by analysis of a combined data set of all sampled characters	163

List of Tables

Chapter 3: Pollination of *Diuris maculata* R. Br. (Orchidaceae) by male *Trichocolletes venustus* bees

Table 3.1. Summary of pollination statistics for 63 plants of <i>Diuris maculata</i> in 2001 at Scheyville National Park.....	92
--	----

Chapter 4: Generalised pollination of *Diuris alba* (Orchidaceae) by small bees and wasps

Table 4.1. Captured bees from 2001, 2002 and 2003 orchid flowering seasons at Site A.	124
Table 4.2. Captured putative pollinators in 2002 and 2003 at Site B.....	125
Table 4.3. Pollinaria removal data, as a proportion of total flowers open for <i>Diuris alba</i> at sites A and B, collected on 19/9/03.	131

Chapter 5: A Molecular Phylogenetic Analysis of *Diuris* (Orchidaceae) based on AFLP and ITS reveals three major clades and a basal species

Table 5.1. Collection details of species samples used in molecular analyses.....	161
---	-----

Chapter 6: Preliminary Pollination Data and Other Observations in 2003

Table 6.1. Removal and fruit set for <i>Diuris punctata</i> at Castlereagh Nature Reserve in 2003.....	176
Table 6.2. Pollinaria removal and fruit set for <i>Diuris aurea</i> at Castlereagh Nature Reserve in 2003.....	178
Table 6.3. Pollinaria removal and fruit set for <i>Diuris</i> sp. aff. <i>punctata</i> at Mellong Swamp in 2003.....	180

Table 6.4. Pollinaria Removal and Fruit Set for <i>Diuris arenaria</i> in mown area under power lines, Anna Bay, 2003.....	182
---	-----

Appendices

Table A1.1 Information on insects captured during field research in 2001.....	215
Table A1.2. Information on insects caught during field research in 2002.....	222
Table A1.3. Information on insects caught during field research in 2003.....	227